

## Breastfeeding, Early Nutrition, and Adult Body Fat

Sandrine Péneau, PhD<sup>1,2,3,4,5,6</sup>, Serge Hercberg, MD, PhD<sup>1,2,3,4,5,6,7,8,9</sup>, and Marie-Françoise Rolland-Cachera, PhD<sup>1,2,3,4,5,6</sup>

**Objective** To examine the association between breastfeeding and adult body fatness, adjusting for nutritional intake in early childhood.

**Study design** Nutritional intakes of 73 healthy infants born in 1984 who participated in the 2-decade-long Longitudinal Study of Nutrition and Growth in Children (Etude Longitudinale Alimentation Nutrition Croissance des Enfants [ELANCE]) were estimated at age 10 months and again at age 2 years. Breastfeeding was defined as any breastfeeding, including partial breastfeeding, regardless of duration. At age 20 years, weight, height, subscapular skinfold thickness (SF), and fat mass (assessed via bioelectrical impedance analysis) were measured.

**Results** In this sample, 64% of the children had been breastfed. In linear regression models adjusted for mother's body mass index and father's profession, breastfeeding was not associated with any of the body fat measurements at 20 years (all  $P > .05$ ). After adding nutritional intake variables (total energy and % energy from nutrients) to the models, breastfeeding became significantly associated with lower SF at 20 years. In particular, breastfed subjects had significantly lower % SF at 20 years after adjustment for energy and % fat intakes at 2 years of age, ( $\beta = -28.25\%$  SF; 95% CI,  $-50.28\%$  to  $-6.21\%$ ;  $P = .013$ ) or when adjusting for energy and % carbohydrates at 2 years of age ( $\beta = -28.27\%$  SF; 95% CI,  $-50.64\%$  to  $-5.90\%$ ;  $P = .014$ ).

**Conclusion** Breastfeeding was not associated with adult body fatness taking into account the usual confounding factors. However, after also adjusting for nutritional intake covariates, a protective effect of breastfeeding emerged. Early nutrition needs to be taken into account when examining the long-term health effects of breastfeeding. (*J Pediatr* 2014;164:1363-8).

The role of breastfeeding in predicting later body fatness has generated substantial interest in recent years. Numerous studies have shown that breastfeeding is protective against overweight and obesity,<sup>1-3</sup> but others have not supported this effect.<sup>4,5</sup> Conflicting findings among studies might be related to the type of statistical adjustment,<sup>1,6,7</sup> body fat indicator of interest,<sup>8</sup> or age at outcome assessment.<sup>7</sup>

Early nutrition is an important factor that may play a role in the association between breastfeeding and later body fatness. An imbalanced diet in early life can alter growth and body fat development. In industrialized countries, infants' diets are generally characterized by high protein and low fat intake,<sup>9-12</sup> and several studies have shown a positive correlation between protein intake and body fat development.<sup>10,13</sup> Recently, data reported from the Longitudinal Study of Children's Nutrition and Growth (Etude Longitudinale Alimentation Nutrition Croissance des Enfants [ELANCE]) showed an association between low fat intake in early life and increased body fatness in adulthood.<sup>12</sup> These data suggest that early fat restriction, like poor nutrition in other contexts, could program later overweight.<sup>14</sup>

A potential influence of nutritional factors, such as maternal feeding restriction of the child<sup>15</sup> and age at introduction of spoon feeding,<sup>16</sup> on the association between breastfeeding and later body fat has been suggested previously. However, to our knowledge, no study to date has investigated the specific contribution of macronutrient intake during infancy. In addition, most previous studies investigated the impact of breastfeeding on later overweight or obesity risk,<sup>3,17</sup> while anthropometric characteristics, such as body mass index (BMI), skinfold thickness (SF), and body composition measurements, have been poorly investigated.

The present analysis is based on the ELANCE cohort of healthy French children followed from early life through age 20 years. We investigated whether breastfeeding is correlated with body fatness in adulthood, taking into account early nutritional factors.

### Methods

Healthy infants and toddlers born in 1984 were invited for a free health examination at age 10 months, 2 years, and 4 years at a health center for children (health center study). Subjects who had completed at least 2 such visits (at 10

BIA	Bioelectrical impedance analysis
BMI	Body mass index
ELANCE	Etude Longitudinale Alimentation Nutrition Croissance des Enfants (Longitudinal Study of Nutrition and Growth in Children)
FM	Fat mass
SF	Skinfold thickness

From the <sup>1</sup>Research Team Nutritional Epidemiology, Center of Research in Epidemiology and Biostatistics, University of Paris 13, Sorbonne-Paris, Paris, France; <sup>2</sup>Institut National de la Santé et de la Recherche Médicale, U1153, Bobigny, France; <sup>3</sup>National Institute of Health and Medical Research; <sup>4</sup>National Conservatory of Arts and Crafts, Bobigny, France; <sup>5</sup>University of Paris 5; <sup>6</sup>University of Paris 7; <sup>7</sup>University of Paris 13, Sorbonne-Paris, Surveillance Unit and Nutritional Epidemiology; <sup>8</sup>Institute for Public Health Surveillance; <sup>9</sup>Department of Public Health, Avicenna Hospital, Bobigny, France

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months and 2 years or at 10 months and 4 years;  $n = 222$ ) were invited to participate in the ELANCE prospective study on nutrition and growth.<sup>13</sup> A total of 126 mothers consented to participate in the follow-up, which included regular home visits by a dietician. Thus, 126 children were examined at age 6 years, 112 were examined at 8 years, 104 were examined at 10 years, 97 were examined at 14 years, and 94 were examined at 16 years. At age 20 years, the cohort was invited to participate in a health examination at a health center for adults, and 73 subjects completed this visit. All of the 73 subjects examined at age 20 years had been examined at age 10 months, and 68 had been examined at age 2 years.

The Ethics Committee of the Paris Cochin Hospital approved this study (CCPPRB 2179). Written informed consent was obtained from the parents during the follow-up and from each participant at age 20 years.

Detailed information on breastfeeding (exclusive or partial; duration) was obtained from the mothers via face-to-face interviews when the child was 10 months of age. In the present analysis, breastfeeding was defined as any kind of breastfeeding, including partial breastfeeding regardless of duration. Breastfeeding was never initiated in the non-breastfed group. Food intake was assessed by a dietitian via the dietary history method, as described previously.<sup>13</sup> In brief, the mother (occasionally the father) was interviewed for approximately 45 minutes about the child's eating patterns during the month before the interview. For a child fed outside the home, information about the child's intake was obtained from the caregiver.

Body measurements at age 20 years were performed in the health center for adults by a trained investigator following standard procedures.<sup>18</sup> All measurements were obtained in the morning with the subject in a fasting state and wearing light underwear. Height was measured to the nearest 0.1 cm with a Seca 240 wall-mounted stadiometer (Seca, Hamburg, Germany). Weight was measured as part of the bioelectrical impedance analysis (BIA) procedure to the nearest 0.1 kg. SF was measured at the subscapular site to the nearest 0.1 mm with a Harpenden calliper (British Indicators Ltd, West Sussex, United Kingdom). Body composition was assessed with an 8-electrode Tanita BC-418 segmental body composition analyzer (Tanita, Tokyo, Japan) after a 30-minute rest. Fat mass (FM) was derived from the analyzer manufacturer's equations.

Several relevant confounders of the association between breastfeeding and subsequent body fat are identified in the literature. In the present analysis, we considered mother's BMI and father's profession (unskilled/semiskilled vs skilled/professional). Mother's weight and height and father's profession were self-declared during the interview at age 10 months. Given recent findings showing that early nutrition can affect later body fatness,<sup>12</sup> nutritional intake at ages 10 months and 2 years (ie, total energy and % energy from each nutrient) were also added into the models.

### Statistical Analyses

BMI was calculated (weight in kilograms divided by the squared height in meters) for each subject. Comparisons

of characteristics between subjects who were followed up to age 20 years and those who were lost to follow-up and between the sexes were based on the Student *t* test or  $\chi^2$  test, as appropriate. The Kolmogorov-Smirnov test was used to assess the skewness of the variables. Only the subscapular SF distribution was skewed; the Wilcoxon Mann-Whitney test was used for this variable. Before the fitting of linear regression models, the SF was log(*e*)-transformed and multiplied by 100. Thus, the regression coefficients are in units of % SF per unit of each independent variable.<sup>19</sup> Comparisons of nutritional intake at age 10 months and 2 years according to the presence or absence of breastfeeding were based on the Student *t* test or  $\chi^2$  test, as appropriate.

The associations between breastfeeding (yes vs no) and adult body measurements (BMI, SF, and FM [BIA]) were analyzed using linear regression models. Regression models were performed with various adjustments: sex only (model 1), sex + mother's BMI + father's profession (model 2), and sex + mother's BMI + father's profession + energy intake at age 10 months (model 3) or at 2 years of age (model 5). Models 3 and 5 were further adjusted for protein (models 4a and 6a), lipid (models 4b and 6b), or carbohydrate (models 4c and 6c) intakes, expressed as % energy. In all models, total energy intake was maintained in accordance with the adjusted multivariate nutrient density model proposed by Willett et al.<sup>20</sup> In the analysis with FM as the outcome variable, height at age 20 years was also added to the models. The strength and direction of the associations between nutrient intake at age 10 months and 2 years and adult body measurements were also considered in these different models.

All outcome variables were available for all subjects, and no variable used for adjustments was missing. All analyses were performed using SPSS 12.0.1 (SPSS Inc, Chicago, Illinois), with the significance level set at  $P < .05$  (2-sided).

## Results

Subjects who were followed up to age 20 years ( $n = 73$ ) and those who were lost to follow-up had similar characteristics in early life. Weight and length at birth; nutritional intake (energy and macronutrients) at ages 10 months and 2 years, and breastfeeding (frequency and duration) did not differ between the 2 groups (all  $P > .05$ ). The 2 groups also had similar BMI and SF at all ages during follow-up. Characteristics of the 73 subjects who participated in the follow-up from age 10 months to age 20 years are presented in **Table I**. Two-thirds of the children had been breastfed, with a maximum duration of breastfeeding of 7.5 months. Nutritional intakes at ages 10 months and 2 years have been published previously.<sup>12</sup>

In the initial sample of 222 children examined in the health centers (health center study), nutritional intake at age 10 months did not differ between breastfed and non-breastfed children, but at age 2 years, fat intake (% energy) was significantly lower in the breastfed children (% fat:  $33.1\% \pm 5.3\%$

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